Standard Operating Procedure

for

LOUISIANA TOTAL MAXIMUM DAILY LOAD TECHNICAL PROCEDURES

Revision 09

Water Quality Assessment Division

Office of Environmental Assessment

Louisiana Department of Environmental Quality

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1 INTRODUCTION

The Louisiana Total Maximum Daily Load Technical Procedures (LTP) outlines and defines procedures which will be followed in determining total maximum daily loads (TMDLs), wasteload allocations (WLAs) for Louisiana dischargers, and load allocations (LAs) for nonpoint sources. Activities that support the development of TMDLs and WLAs are also described.

This document is the ninth revision of an LTP submitted to USEPA Region VI as a draft memorandum of understanding (MOU) in 1988 by LDEQ. Since the first LTP was developed, the State Water Quality Standards have been revised, newer water quality models have been developed, and additional guidance documents have been developed by the USEPA. Further, experience gained over the years in applying the LTP provides an improved perspective for needed revisions.

1.1 Purpose

Water quality based effluent limitations for point source permitting are based on the TMDL and WLA. The purpose of the water quality based approach is to establish pollution control limits for waters not meeting the State's water quality standards. In this context, the TMDL process includes assessment for water quality standards attainment, identification of water quality limited waters, the ranking and targeting of high priority waters, and the development of TMDLs that should result in the attainment of water quality standards when implemented (USEPA, 1991a).

The purpose of the LTP is:

* to encourage a rational, holistic, geographic approach toward solving water quality problems from the perspective of instream conditions,
* to facilitate the development of technically sound and legally defensible decisions for attaining and maintaining water quality standards,
* to streamline the TMDL and WLA development process through establishment of specific modeling requirements, terminology, critical conditions, parameter values, and allocation procedures,
* to reduce the technical justification verbiage in TMDL reports,
* to specify the general technical management and planning procedures to be followed in TMDL development,
* to document a standard report outline and format, and
* to clarify these elements for interested parties outside LDEQ and EPA-VI.

This document provides a consistent statement of policy and a basis for technical selection of parameters and procedures. It is not the purpose of this document to remove the requirement for scientific and engineering judgment from TMDL development. Many other references and sources of authoritative information are available. Selection of procedures, which are in conflict with the LTP, should only be made with caution, and be technically documented and justified. Approval of such deviations by LDEQ is required in order for such a procedure to provide a basis for permit modification or Management Plan update.

Procedures and standards of practice for toxic pollutants are not yet fully developed; however, most sections of the LTP are equally as applicable to toxic pollutants as to conventional (oxygen demanding) pollutants. A section is also specifically dedicated to toxic TMDL development.

Additional information on the process the State uses to identify water quality limited (WQL) and effluent limited segments, to identify and prioritize waters requiring a TMDL, and the procedures for public review and participation are described in the Louisiana Continuing Planning Process document. These processes are, therefore, not included in this document. In addition, the requirements for project and survey planning and reporting have been revised and transferred to the LDEQ QA/QC document

1.2 Statement of Policy

The State of Louisiana is committed to the development of TMDLs that are consistent with the requirements of the Clean Water Act (CWA) and applicable State statutes. In this regard, permit limitations will be established at a level that will assure attainment of the applicable water quality standards.

It is also recognized that some of the existing water quality standards for specific sites are not attainable. In these cases, appropriate water quality standards revisions should be made and TMDLs developed based upon the revised standards. Revisions to water quality standards will be consistent with the CWA and associated regulations.

1.3 LTP Amendment and Revision

This document will require clarification and revision throughout its useful application lifetime. At any time an update of the LTP may be proposed by LDEQ. This document will be revised frequently as necessary to reflect new procedures and knowledge gained as the TMDL experience base expands or changes in policy. At a minimum, these procedures should be reviewed every year and revised, if necessary.

2 TMDLs

This section describes the concepts and terms that form the basis for TMDL development . The definitions provided in this section generally follow those provided by the USEPA (1985, 1991a). In addition, the State policy for application of a factor for growth and safety, and allocation of loads is described.

2.1 Definitions

A load is the amount of matter or thermal energy that is introduced into a receiving water. A load may be caused by man (a pollutant) or by nature (natural background load). For oxygen demanding material, load may be expressed separately for separate components (e.g. CBOD, NH_3-N), or may be expressed as a total oxygen demand.

The load capacity of a stream is the greatest amount of loading that a water can assimilate without violating water quality standards. Load capacity is equal to the TMDL plus any excess capacity. Load capacity may be determined on a seasonal, annual, flow, and/or temperature variable basis. If seasonality is not applicable to the determination of the load capacity, annual critical conditions are used in TMDL development. Critical conditions are discussed further in another section of this document.

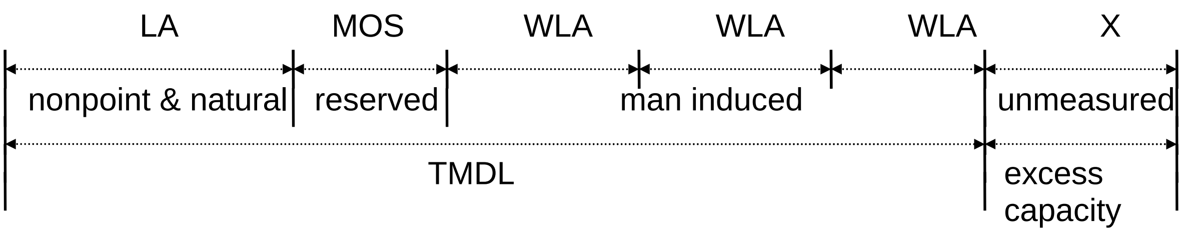
The load allocation (LA) is the portion of a receiving water's load capacity that is allocated to one or more of its existing or future nonpoint sources of pollution or to natural background sources. Load allocations are best estimates of the loading and may range from reasonably accurate estimates to gross allotments, depending on availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and nonpoint source loads should be distinguished. For calibrated modeling studies, the LA may often be estimated from the headwater flow, incremental flow loads, and nonpoint loads required for calibration. Nonpoint loads may include sediment oxygen demand (SOD) and resuspension.

A wasteload allocation (WLA) is the portion of a receiving stream's loading capacity that is allocated to one or more of its existing or future point sources of pollution. The WLA constitutes a type of water quality based effluent limitation.

Every TMDL developed will also have a margin of safety (MOS) to account for modeling uncertainty, data inadequacies, and future growth and safety. The MOS may be explicit or implied. For reasonably conservative constituents such as metals, DEQ typically uses an explicit MOS expressed as a percentage of the TMDL. For nonconservative constituents such as dissolved oxygen, DEQ typically uses a combination of explicit and implied MOS. The implied MOS is contained in the conservative assumptions used in the projection analysis, i.e., 90th percentile temperature and 7Q10 flow occurring at the same time, assuming that the facility design flow occurs at the 7Q10 stream flow, assumptions related to the decay and other coefficients, etc. DEQ typically reserves an explicit MOS of twenty percent (20%) of each WLA for nonconservative constituents. However, in many situations, LDEQ may determine that a smaller or larger MOS is appropriate. For example, if growth beyond that already incorporated into the design flows is considered to be unlikely, and if there is a high level of confidence in modeling projections, then the MOS might be decreased. Alternatively, waters in which a significant number of new dischargers are anticipated may require an increased MOS. If a facility plan with a population/loading projection is available, that projection may be used in determining the reserve for growth.

The TMDL establishes the allowable loadings or other quantifiable parameters for a waterbody and thereby provides the basis for water quality based controls. The total maximum daily load (TMDL) for a substance is the sum of the individual WLAs for point sources, the LAs for nonpoint sources and for natural background, and the MOS. The TMDL is less than or equal to the load capacity.

The relationship between these quantities may be diagrammed as:



2.2 Allocation of Loads

Allocation of loads to the various point and nonpoint sources is a difficult management decision. Within the constraints of the TMDL requirements, the selection of allocation methodology to be applied is a responsibility of the State.

Various allocation schemes have been proposed, and each may be most appropriate in a particular circumstance. The allocation strategy should:

* be protective of the environment and reduce the risk of violation of water quality standards,

* be equitable to all regulated parties,

* provide a reasonable distribution of costs of load reductions, and attempt to minimize overall costs of meeting TMDL requirements.

If all point source dischargers are of similar size, it will usually be most equitable to set equal concentration limits for each discharger. Where both small and large dischargers are involved, the Louisiana "Statewide Sanitary Effluent Limitations Policy should be followed, so far as possible, in setting limitations on smaller sanitary dischargers.

If point source dischargers are not similar, for example, if industries and municipalities are involved, it may be more appropriate to require percent removal, or equal reductions from technology based limits (e.g. secondary or BAT guidelines), rather than simply requiring equal concentration limits. Note, however, that for some industries such as food processors, LDEQ has determined that the character of the waste and waste treatment methods are sufficiently similar to sanitary waste to be included in an overall allocation without consideration of wastewater source or specific industry category.

If multiple point source dischargers are located in such close proximity as to approximate the impact on the stream of a single larger point source, the analysis will be conducted in accordance with the policy for aggregate areal discharge flows stated in the Louisiana Continuing Planning Process.

If multiple point source dischargers are owned by a single entity, a city for example, it may be appropriate to consult with the permittee to determine the most cost-effective allocation. This consultation is at the discretion of LDEQ. If such an allocation strategy is pursued, contact with the regulated municipalities or industries should be initiated as early as practical during the TMDL development process, and final TMDL determination should not be delayed because of lack or inadequacy of response from the regulated dischargers.

Nonpoint source tradeoffs are allowed in the allocation process. If best management practices (BMPs) or other nonpoint source pollution controls make more stringent LAs practicable, then wasteload allocations can be less stringent. Because of the uncertainty that is usually associated with nonpoint source loading estimation and BMP reductions, a phased TMDL is likely to be required when such trades are proposed.

The sensitivity of the load capacity of the stream to the location of discharge(s) must be considered in the allocation determination for TMDLs, especially on non-conservative constituents. For large, multiple point source discharger allocations, frequent updating of the TMDL could result in excessive costs in labor and delays in permit issuance and other management actions. Updating of the TMDL will, therefore, ordinarily only be performed if more than fifteen percent (15%) of the load changes discharge location, or if there is more than a ten percent (10%) change in the total of the WLAs allocated to dischargers.

For conservative constituents, near-field analysis of mixing zones or zones of initial dilution may be required in addition to the overall TMDL calculation. Occasionally a similar mixing analysis will be required for non-conservative constituents if the effect of multiple dischargers within a localized area is significant. Additional guidance on these topics is provided in the section dealing with toxic wasteload allocations.

2.3 Phased TMDL

When developed according to a phased approach, the TMDL can be used to establish load reductions where there is impairment due to nonpoint sources or where there is lack of data or adequate modeling. Lack of information about certain types of pollution problems (for example those associated with nonpoint sources or with certain toxic pollutants) will not be used as a reason for delay of implementation of water quality based controls (USEPA, 1991a).

The phased approach TMDL will include a margin of safety (MOS) to account for uncertainties in the model, growth, safety, etc.

The phased TMDL will include a schedule for the implementation of control mechanisms, and attainment of standards. Since additional monitoring may also be required by the TMDL to support the assessment of standards attainment and possible TMDL revision, the phased TMDL will normally include a monitoring plan. This plan should include a description and assessment of existing data and the design of additional monitoring or special studies that will be required. The objectives of the monitoring plan may include:

* assessment of water quality standards attainment,
* verification of pollutant source allocations,
* model calibration or modification,
* measurement of stream discharge, dilution, and development of mass balances,
* evaluation of effectiveness of point and nonpoint source controls.

The monitoring plan will include a provision for appropriate QA/QC. Data from discharge monitoring reports (DMRs) and data collected by other agencies and organizations should also be considered. A proposed schedule for data collection and evaluation must also be included in the plan.

The phased TMDL may also be used where there is clearly a need to reevaluate the existing water quality standards and establish standards more appropriate to the waterbody. Reference stream data and/or no load modeling analyses may be used to support a phased TMDL. Where natural conditions alone create dissolved oxygen concentrations less than 110 percent of the applicable criteria means or minima or both, a model projection may be used to establish natural background conditions, and the minimum acceptable concentration utilized in the initial TMDL of a phased TMDL would be 90 percent of the natural concentration. Both point and non-point anthropogenic loading must be considered in calculating the point source WLA; the estimated non-point anthropogenic loading may be reduced by an amount consistent with the implementation of non-point BMPs for that calculation. If the natural dissolved oxygen concentration is less than 3.3 mg/L, a use attainability analysis should be incorporated in the initial TMDL/WLA process.

This procedure (the 10% rule) should not be considered to be a substitute for use attainability analysis (UAA) or determination of appropriate standards, but is intended to prevent delays in providing protective TMDLs and WLAs for waterbodies where a lack of data prevents an immediate UAA, and where the waterbody receives discharges from smaller point sources and may therefore not rank high in priority for scheduling of UAAs. Following completion of an approved UAA for a waterbody, recalculation of appropriate TMDLs and WLAs should be performed.

2.4 Toxic TMDLs and WLAs

TMDLs and WLAs for toxic substances and toxicity may be developed using one or more of three technical approaches:

* chemical specific,
* whole effluent toxicity, and
* biocriteria/bioassessment.

In each situation, selection of the approach for protecting receiving water quality is dependent on the specific environmental conditions and regulatory resources available. The chemical specific approach is likely to be most commonly applied. Whole effluent toxicity has recently become a common test used in NPDES permitting, and is therefore likely to be utilized in future toxic TMDLs. Application of the biocriteria/bioassessment approach is more difficult and currently less practical because methodologies are not fully developed and resources are not as readily available.

The Louisiana Water Quality Standards recognize a mixing zone in which criteria related to chronic exposure may not apply. Within the mixing zone, and outside a small zone of initial dilution (ZID) near the discharge, no acute toxicity should be permitted. Except in special cases, the ZID will follow the general definitions provided in the state water quality standards.

The requirement for no acute toxicity applies to concentrations calculated from dilutions of whole effluent acute toxicity units, to DO, and to other specific chemicals. It is generally assumed that for dissolved oxygen, a minimum level of 2 mg/L must be maintained to avoid acute toxicity. For other specific pollutants, values for protection of aquatic life from acute toxicity are published in the State standards.

Toxic criteria apply to streams according to their uses, to both chronic and acute protection of fish and wildlife, and to the protection of human health. The toxic criterion on which a limitation is based will be that applicable criterion which results in the most stringent limitation. The next subsection of this document clarifies application of the water quality standards to intermittent streams and man-made watercourses.

Criteria relating to chronic human exposure including carcinogenicity, or to chronic exposure of aquatic life will apply outside the mixing zone. Critical stream flow for application of these chronic criteria will be as defined in the water quality standards (LDEQ, 1991c), and in EPA guidance documents. The appropriate critical flow for carcinogenic pollutants is the harmonic mean flow as defined in the state water quality standards.

Special attention is required to assure that discharges of persistent and/or highly bioaccumulative toxic pollutants do not result in a loss of use or standards violation. The numerical criteria for these substances have been selected to be protective of water quality for typical point source discharges. Additional analysis and modeling may be required in cases of diffuse sources or multiple discharges to a waterbody.

2.5 Intermittent Streams and Man-made Watercourses

For intermittent streams, standards and designated uses are typically seasonal; these seasonal criteria should be adhered to when determining effluent limitations. Several intermittent streams in Louisiana have no designated uses during the dry season and may require that limits be based on the standards and dilution capacity of the next downstream perennial water body. However, the Louisiana Surface Water Quality Standards clearly state that in the event of a wastewater discharge to an intermittent stream, several criteria must be met:

1) The discharge will not by itself or in conjunction with other discharges cause the general criteria to be exceeded;

2) the discharge will not by itself or in conjunction with other discharges cause exceedance of the applicable numerical criteria in any perennial water body which receives water from the intermittent stream;

3) sanitary discharges will be disinfected to protect the public from health hazards that may result from inadvertent secondary contact; and

4) the discharge will not exceed the general criteria for toxic substances.

Therefore, even if there are no uses designated for an intermittent stream during the dry season, the effluent must be limited in such a manner that the criteria listed above are not violated. In many instances, these criteria will call for end-of-pipe effluent limitations, particularly in the cases where the only water in the streambed is wastewater during the dry season.

The criteria for man-made watercourses are similar to those listed for intermittent streams. In the event that a wastewater discharge is proposed for an approved and designated man-made watercourse, the following conditions must be met:

1) Same as above;

2) the discharge will not by itself or in conjunction with other discharges cause exceedance of the applicable numerical criteria in any water body which receives water from the man-made watercourse;

3) the discharge will not by itself or in conjunction with other discharges cause exceedance of the numerical criteria for toxic substances.

Man-made watercourses have criteria and designated uses as specified in the numerical criteria tables. Any effluent limitations must be determined in consideration of the water body's criteria and uses.

2.6 Non-Chemical Factors

Although chemical contaminant based loads and load reductions form the major thrust of all past, as well as most future, TMDLs, the State and EPA recognize that, in some situations, water quality standards can only be attained if non-chemical factors such as hydrology, channel morphology, and habitat are addressed. In such cases it is appropriate to use the TMDL process to establish control measures for quantifiable non-chemical parameters that are preventing the attainment of water quality standards. Control measures in this case would be developed and implemented to meet a TMDL that addresses these parameters in a manner similar to chemical loads (USEPA, 1991a). The phased TMDL approach may be particularly appropriate for development of non-chemical factor TMDL requirements.

3 WATER QUALITY MODELING AND ANALYSIS

Water quality modeling is central to the development of TMDLs. This section describes the approaches to modeling used in LDEQ for projection of water quality under specific environmental and pollutant loading conditions. In all cases, the primary consideration that should be given in application of these models is that the model must provide a reasonable scientific basis and allow a confident and defensible water quality decision.

3.1 Levels Of Water Quality Analysis

Four levels of water quality analysis are recognized by LDEQ. This section describes each level of analysis and recommends when each is to be used. For dissolved oxygen, the model should represent DO at a depth of either 1 meter or 1/2 the depth where the depth is less than 2 meters.

3.1.1 Level 1. Dilution Models

In these analyses a simple mass balance of ultimate biochemical oxygen demand (UBOD) is performed. Only upstream critical flow, critical dissolved oxygen content, and the discharge design flow are required. This analysis conservatively assumes that all discharged oxygen demand is instantaneously realized. If the minimum receiving water DO remains above the standard under secondary treatment then no further analysis is necessary. UBOD may be calculated as

$$UBOD = 1.5*BOD_5 + 4.3*NH_3\text{-}N.$$

A similar approach, assuming toxic contaminants are conservative, may be applied to toxic discharge evaluations and limitations.

3.1.2 Level 2. Uncalibrated Models

In these analyses an uncalibrated DO projection model is employed. This DO model will frequently be an analytical Streeter-Phelps model; however, any other DO model may be applied without calibration. This type of model is used in setting permit limits for dischargers according to the table at the end of this section and for pre-survey analyses. This model should account for stream reaeration, CBOD deoxygenation, NBOD deoxygenation and sediment oxygen demand (SOD). Model inputs should be based upon field observations of stream width, depth, and velocity. A time-of-travel study may also be required. No water quality data is required.

3.1.2.1 Minimum Data Uncalibrated Models

In these analyses the model is based on hydrologic data for one or more short reaches representative of the length of stream that is impacted by a discharge or discharges.

3.1.2.2 Full Data Uncalibrated Models

In these analyses the model is based on hydrologic data for most of the length of stream that is impacted by a discharge or discharges. These models may be hydrologically calibrated but are not calibrated to water chemistry.

3.1.3 Level 3. Calibrated Models

In these analyses model hydraulic and kinetic rates are estimated from data collected during an intensive survey. A model is said to be calibrated if these hydraulic and kinetic rates cause the model to adequately reproduce the measured hydraulic and water quality data. Development of a calibrated model requires extensive measurement of water quality, stream geometry and hydrology on one occasion. Procedures for performing such a survey may be found in the LDEQ QA/QC document.

3.1.4 Level 4. Calibrated and Verified Models

In these analyses data from two separate water quality surveys are required. One survey is used to calibrate the model as described in Level 3. The calibrated model is adjusted to account for changes in stream loads and temperature during the second survey and is then used to predict water quality observations during the second survey. Any additional model parameters that are altered during verification from their calibration settings should be documented and a detailed rationale provided for the appropriateness of such a variation. The model is considered verified when it adequately reproduces this second set.

3.1.5 Guide to Levels of Analysis

Table 1 should be used as a guide to the minimum level of modeling analysis to be performed for the given discharge scenario to develop a WLA. This table applies to sanitary dischargers and conventional (non-conservative) pollutants in small watersheds with few point sources and few tributaries. For medium to large sized watersheds and in cases where significant reductions in nonpoint source loading are required, calibration is recommended. Treatment levels in this table are specified as mg/l of $CBOD_5$ and NH_3-N. An uncalibrated model may be used in any situation in which the facility flow is less than 10% of the critical stream flow. For sanitary facility flows less than 0.5 MGD, WLAs may be assigned according to the "Statewide Sanitary Effluent Limitations Policy" and the need for a TMDL determined on a case-by-case basis. An uncalibrated model may always be used as a screening model to estimate the level of resources that may be required for the TMDL. An uncalibrated model may always be used to determine the initial phases of a phased TMDL.

3.1.6 Data Requirements by Level of Analysis

This section outlines the field and laboratory data necessary for each of the four levels of analysis described in Sections 3.1.1 through 3.1.4.

3.1.6.1. Level 1. Dilution Models (Secondary Treatment Only)

No water quality or depth and velocity data are required. Upstream critical flow may be estimated from local flow data or default values may be used. Upstream DO is assumed to be 90% of the saturation value at the 90th percentile temperature for the season. Secondary discharge UBOD is calculated as

$$UBOD=1.5\ (BOD_5) + 4.3\ (NH_3\text{-}N)$$

All UBOD is assumed to be instantly satisfied upon mixing with the receiving stream.

Table 1 - Guide to Levels of Analysis

OXYGEN DEMANDING TREATMENT LEVEL	FACILITY FLOW IN MGD			
	< 2.0	2.0 - 5.0	5.0 - 10.0	> 10.0
NO POINT SOURCES	UNCALIBRATED	UNCALIBRATED	UNCALIBRATED	UNCALIBRATED
SECONDARY	DILUTION OR UNCALIBRATED	DILUTION OR UNCALIBRATED	DILUTION OR UNCALIBRATED	DILUTION OR UNCALIBRATED
FACILITY FLOW < 10% OF THE CRITICAL STREAM FLOW	UNCALIBRATED	UNCALIBRATED	UNCALIBRATED	UNCALIBRATED
20/10	UNCALIBRATED	UNCALIBRATED	UNCALIBRATED	FULL DATA UNCALIBRATED
10/10	UNCALIBRATED	UNCALIBRATED	FULL DATA UNCALIBRATED	CALIBRATED
10/5	UNCALIBRATED	UNCALIBRATED	FULL DATA UNCALIBRATED	CALIBRATED
10/2	UNCALIBRATED	FULL DATA UNCALIBRATED	CALIBRATED	CALIBRATED
5/2	UNCALIBRATED	FULL DATA UNCALIBRATED	CALIBRATED	CALIBRATED

3.1.6.2. Level 2. Uncalibrated Models

Receiving stream characteristics may be estimated from field observations. No water quality data are required. Upstream critical flow may be estimated from local flow data or default values may be used. Upstream DO is assumed to be at or between the criteria and 90% of the saturation value at the 90th percentile temperature for the season. Upstream CBOD and NBOD may be estimated from appropriate reference stream data.

Distributed CBOD and NBOD loading resulting from natural background loads or from unidentified or nonpoint source loads may be determined through reference to appropriate background stations, stations used in calibrated models, or survey data from appropriate reference streams

Other model inputs should be determined as discussed in Section 3.3, Determining Model Inputs.

3.1.6.3. Levels 3 and 4. Calibrated and Calibrated/Verified Models

For a calibrated modeling analysis at least one intensive water quality and hydraulic survey is necessary. The water quality portion should minimally include BOD series, nitrogen series, total suspended solids, chlorides or conductivity, dissolved oxygen, pH and temperature. Other parameters, such as TDS, VSS, TOC, COD, color, and chlorophyll-a, may be required, as determined on a case-by-case basis, based on model requirements and State manpower and laboratory resource availability. The hydraulic portion should include the flow of point sources and tributaries and depth, width, flow, and time of travel measurements at numerous stream sampling stations. Additional data, such as stream dispersion, sediment oxygen demand, reaeration, and algal activity may be necessary according to system complexities identified in past work, reconnaissance surveys, and pre-survey uncalibrated modeling analyses. For calibrated/verified models two intensive surveys as described above are necessary. The requirement for a calibrated/verified model will be determined on a case-by-case basis considering model accuracy and applicability, manpower and field equipment availability, and laboratory availability.

3.1.7 Model Characteristics

Models can be categorized according to various characteristics. Four important categories (USEPA, 1991a) which should be considered in model selection are:

* temporal characteristics
* spatial characteristics
* specific constituents and processes simulated
* transport processes.

3.2 LDEQ Water Quality Models

The selection of a water quality model depends on a number of factors. Some of these factors are listed in Section 3.1 where the study level of effort and model characteristics are discussed. A model should be selected based on its adequacy for the intended use, for the specific waterbody hydrology and dischargers, and for the critical conditions applied to that waterbody. Typical TMDL studies which primarily consider point source impacts in non-tidal streams may require little justification for model selection. Other situations will require more extensive justification of model selection based on study site characteristics, model characteristics, and study objectives.

In general, the least sophisticated model capable of addressing all relevant receiving stream characteristics should be selected. Less sophisticated models usually require fewer resources and less data, and in some cases, may produce more robust and defensible results. When available and appropriate, models supported by the USEPA Center for Exposure Assessment Modeling (CEAM) are preferred over other models of similar applicability.

This section briefly describes those models most often used for Louisiana waterbodies. Additional documentation for each model is available at LDEQ or from EPA. These are just a few of the many public domain models available from EPA and other agencies. If the model selected is not listed below, then justification of the model selection and complete model documentation must be formally submitted along with the required TMDL report.

3.2.1 LIMNOSS/XLIMNOSS

LIMNOSS is a version of the USEPA AUTO QUAL model. It is written in FORTRAN and is available on the LDEQ mainframe computer. XLIMNOSS is the personal computer version of LIMNOSS. LIMNOSS/XLIMNOSS considers only a single stream channel. Tributaries are not simulated but may be included as point source loads to the simulated channel. The simplicity of the LIMNOSS/XLIMNOSS input makes it desirable for unbranched systems. Analysis of branched systems may be accomplished by sequencing the model output from tributaries as point sources to separate downstream models. XLIMNOSS was developed by the state of Louisiana (Waldon, 1988) to allow use of reaeration equations that more closely fit Louisiana conditions.

3.2.2 LACOULEE

LACOULEE is a windows executable version of the USEPA AUTOQUAL model. It is written in FORTRAN and is available via the DEQ website. This model considers only a single stream channel. Tributaries are not simulated but may be included as point source loads to the simulated channel. The simplicity of the LACOULEE input makes it desirable for unbranched systems. This model allows for use of the Louisiana reaeration equations. The output can be generated in both graphical and report formats. Additionally, LACOULEE can generate the sensitivity analysis both in report form and graphical form.

3.2.3 QUAL-TX, QUAL2E, LA-QUAL

These models are modified versions of the U.S. EPA QUAL-II model. QUAL-TX was developed by the state of Texas for use in water quality modeling and management. QUAL2E is supported by the USEPA Center for Exposure Assessment Modeling (CEAM) in Athens, Georgia. Both programs are written in FORTRAN and are available on the LDEQ mainframe computer. QUAL2E and QUAL-TX are distributed in an executable form for the IBM-PC, as well as in source code. QUAL-TX and QUAL2E are steady state one-dimensional models that allow for complex branching. QUAL-TX is capable of simulating tidally averaged flows. The QUAL-TX and QUAL2E inputs are more complex than LIMNOSS input, and are less easily implemented or modified. LA-QUAL was developed by the state of Louisiana to allow use of reaeration equations that more closely fit Louisiana conditions.

3.2.4 Branch, LTM, And BLTM

These models were developed by the USGS. They have been implemented on the IBM PC/AT, and are currently available on the LDEQ mainframe computer. Branch is a hydrodynamic model, that is, it simulates flow in branched streams. LTM, the Lagrangian Transport Model, is a simple dynamic model that simulates unidirectional flow, dispersion, transfer, and chemical transformations. BLTM, the Branched Lagrangian Transport Model, is a modification of the LTM that incorporates bi-directional flow and branching. These models are particularly appropriate for modeling streams on which dye transport studies have accompanied water quality studies. Because flows in many of the streams in Louisiana are too slow for accurate measurement, and are also frequently bi-directional, these models are especially appropriate for modeling a large fraction of the Louisiana streams.

3.2.5 Mixing Models

CORMIX 2.10 is currently the only model that may be generally accepted for modeling near-field zone of initial dilution (ZID) and mixing zone (MZ) dilution. CORMIX can be used to model surface discharges as well as single-port and multi-port diffusers. As other models in this CORMIX family are released by EPA, they may also be utilized. Since these models have had limited field testing, applicability to the proposed conditions must be demonstrated.

In special cases the jet model of Fischer may be used, but applicability of this model to the proposed conditions must be demonstrated. At a minimum, centerline velocity must be greater than 0.5 feet per second, the jet diameter must be less than the water depth, discharge depth must be such that impingement on the surface or bottom does not occur, and the effluent must not be significantly affected by positive or negative buoyancy.

3.2.6 Other Models

Use of a limited number of models greatly increases the efficiency of model application and review. However, the models listed above may not be adequate or appropriate for all situations. Selection of additional models will depend on the system to be simulated and on computer hardware and software availability. In order to facilitate review and future applications, only public domain models with extensive documentation and support should be considered. Examples of such models are RECEIV, WASP, BASINS, HSPF, PLUMES, and DEM.

3.2.7 Support Models

To assist in developing modeling input data sets from the field survey data, several support models are used. GSBOD and GSNBOD are used to calculate the ultimate carbonaceous and nitrogenous BOD species (UCBOD and UNBOD, respectively) in the water column samples. These models, written by Waldon (1989), use laboratory time trace data to calculate first-order decay constants, lag times and ultimate values for CBOD, NBOD and total BOD. In addition, a spreadsheet named

COMPREAR has been developed to compute the reaeration coefficient from various equations that have been applicable to Louisiana waterbodies in the past. The appropriate coefficient is selected based on the limiting values that apply to each equation and best professional judgment of the modeler. The Leopold equations given below are used to scale the velocity (U), width (W), and depth (H) of a free flowing stream from a lower value of flow (Q) to a higher value or from a higher value of Q to a lower value. Note that the exponents add to one and the coefficients multiply to 1. This is known as the rule of ones. This method is not appropriate for streams in which the depth and width are not dependent entirely upon flow (such as waterbodies where flow approaches zero, but contain some depth).

$U = aQ^b$ $\quad$ $H = cQ^d$ $\quad$ $W = eQ^f$

$b + d + f = 1$ $\quad$ $(a)(c)(e) = 1$

The Leopold equations presume that the water surface width and average depth of a stream are zero at zero flow. Most Louisiana streams retain a significant width and depth at zero flow. The equations have therefore been modified to allow for a zero flow width and depth. The Modified Leopold equations are:

$W = aQ^b+c$ $\quad$ $H = dQ^e+f$ $\quad$ $u = gQ^h$

Note that the “rule of ones” does not apply to the modified equations.

3.3 Determining Model Inputs

This section describes the methods to be used in estimating the common water quality model inputs. When implementing these methods, the resulting model inputs should be deemed reasonable compared to literature or Louisiana based values for similar receiving waters.

3.3.1. Reaeration Rates, K_2 (day^{-1} @ 20 degrees C, base e)

For both uncalibrated and calibrated models, the methods cited in Table 2 are acceptable for the specified stream conditions:

For a calibrated model, an appropriate reaeration formula should be identified. Preferably, a reaeration formula should be selected which provides results similar to values measured using gas tracers at near critical conditions. Alternatively, when field measurements are unavailable, the reaeration formula selection should be based on modeling experience on similar streams, on the similarity to streams used in development and testing of the formula (Bowie, et al., 1985), on reference stream values for the stream category, and/or on calibration of DO values.

3.3.2. Carbonaceous Deoxygenation Rate, K_d (day^{-1} @ 20 degrees C, base e)

For an uncalibrated model:

K_d = .5; Depth H < 1 foot

K_d = .4; 1 $\leq$ H < 2 feet

K_d = .3; H $\geq$ 2 feet

Where available, "bottle" decay rates may also be used in uncalibrated analyses. For a calibrated model, K_d will be obtained by matching calculated stream UCBOD profiles to observed profiles, general agreement with "bottle" decay rates may also be used as a guide for decay rate estimation prior to calibration.

3.3.3. CBOD Settling, K_s (day^{-1}, base e)

For uncalibrated models:

K_s = .1 for Secondary Treatment

K_s = .08 for 20/10 ($CBOD_5/NH_3$-N)

K_s = .05 for 10/10 and lower

For calibrated models, estimates of K_s may be based on TSS and filtered/unfiltered CBOD data.

3.3.4. Nitrogenous Deoxygenation Rate, K_n (day^{-1} @ 20 degrees C, base e)

For an uncalibrated model:

K_n = .4; Depth H < 1 foot

K_n = .2; 1 $\leq$ H < 2 foot

K_n = .1; H $\geq$ 2 foot

Suggested methods for estimating UNBOD are:

UNBOD = 4.3* NH_3-N

UNBOD = UBOD – UCBOD

For a calibrated model, K_n will be obtained by matching calculated stream UNBOD profiles to observed profiles, general agreement with "bottle" decay rates may also be used as a guide for decay rate estimation prior to calibration.

3.3.5. Sediment Oxygen Demand, SOD (gm/m2/day @ 20 degrees C, base)

For uncalibrated models:

SOD = 2 for secondary - oxidation ponds or high TSS

1.5 for secondary - otherwise

SOD = 1.0 for 20 $CBOD_5$

SOD = 0.5 for 10 $CBOD_5$

For calibrated models, SOD may be determined by measurement or calibration, and may be reduced as listed above for TMDL projections.

When a value of 0.5 or less is specified for SOD it is appropriate to require a TSS limitation in the TMDL and associated WLAs.

3.3.6. Algal Photosynthesis and Respiration

For uncalibrated models, algal photosynthesis and respiration are assumed to be zero.

For calibrated models, algal photosynthesis and respiration will be estimated through calibration or special field studies. If algal effects are significant, then special algal field studies should be performed.

3.3.7. Dissolved Oxygen

DO saturation will be in agreement with Standard Methods (Clesceri, et al., most recent edition) for both calibrated and uncalibrated models.

3.3.8. Temperature Correction of Kinetics

These corrections should be applied in both calibrated and uncalibrated analyses.

$K_2(T) = K_2(20)(1.024)^{(T-20)}$	Reaeration
$K_d(T) = K_d(20)(1.047)^{(T-20)}$	CBOD Decay
$K_n(T) = K_n(20)(1.07)^{(T-20)}$	NBOD Decay
$SOD(T) = SOD(20)(1.065)^{(T-20)}$	SOD

Table 2 - Reaeration Equations and Applicability

Author(s)	Equation K_2 =	Units	Applicability
Bennett & Rathbun (1972) **	$20.2\ U^{0.607} / H^{1.689}$	English	Based on a reanalysis of historical data.
Churchill et. al. (1962) **	$11.6\ U^{0.969} / H^{1.673}$	English	Based on observed reaeration rates below dams from which oxygen deficient water was released. 2'≤H≤11'; 1.8fps≤U≤5 fps
Isaacs & Gaudy (1968) **	$8.62\ U / H^{1.5}$	English	Developed using regression analyses from data collected using a recirculating cylindrical tank. 0.6fps≤U≤1.6fps; 0.5'≤H≤1.5'
Langbein & Durum (1967) **	$7.60\ U / H^{1.33}$	English	Based on synthesis of data from O'Connor-Dobbins (1958), Churchill et al. (1962), Kernkel and Orlob (1963), and Streeter et al. (1936).
Long (1984) **	$1.923\ U^{0.273} / H^{0.894}$	Metric	Known as the "Texas" Equation. Based on data collected on streams in Texas.
Negulescu & Rojanski (1969) **	$10.9\ (U / H)^{.85}$	English	Developed from a recirculating flume with depths less than 0.5 feet.
O'Connor & Dobbins (1958) **	$12.9\ U^{0.5} / H^{1.5}$	English	Moderately deep to deep channels; 1'<H<30', 0.5fps≤U≤1.6fps; 0.05≤K_2≤12.2/day.
Owens et. al. (1964) **	$23.3\ U^{0.73} / H^{1.75}$	English	This is a second formula developed by Owens et al., and applies for 0.1fps≤U≤1.8fps; 0.4'≤H≤11'
Padden & Gloyna (1971) **	$6.9\ U^{0.703} / H^{1.054}$	English	Regression analysis performed on data where 9.8≤K_2≤28.8/day.
Tsivoglou & Neal (1976)**	0.11 (Îh / t)	English	Based on data collected on 24 different streams using radioactive tracer method. Applies for 1cfs≤Q≤10 cfs
Tsivoglou & Neal (1976)**	0.054 (Îh / t)	English	Based on data collected on 24 different streams using radioactive tracer method. Applies for 25cfs≤Q≤3000 cfs
Tsivoglou & Neal (1976) (Derivation)	3600 * 24 * 0.11 US	English	Based on data collected on 24 different streams using radioactive tracer method. Applies for 1cfs≤Q≤10 cfs
Tsivoglou & Neal (1976) (Derivation)	3600 * 24 * 0.054 US	English	Based on data collected on 24 different streams using radioactive tracer method. Applies for 25cfs≤Q≤3000 cfs
Louisiana (1996) ***	$2.18[(1+6.56U)/H]$	English	Based on empirical data collected by the LA DEQ. 0.3'<H<3.0', .02fps<U<0.8fps
Maximum K2	25	English	EPA Policy in the absence of a measured value
Minimum K2	2.3/H	English	Louisiana Policy

U = The average velocity for the sampled reach, fps or mps
H = The average depth for the sampled reach, feet or meters
Metric Conversion = fps or feet multiplied by .3048 to convert to mps and meters.
K_2 units are day $^{-1}$, at 20 degrees Celsius, base e

Îh / t = drop in water surface elevation, feet / time of travel, days
S = slope
** Rates, Constants, and Kinetics Formulations in Surface Water Quality Modeling (Second Edition), June 1985, EPA/600/3-85/040. Table 3-6 on pages 103-106.
*** Reaeration in Shallow, Low-Flow Louisiana Stream Reaches - Verification of the Louisiana Equation, Michael G. Waldon, March 27, 1996. Equation 2, Page 1.

3.3.9. Stream Flow Balance

For calibrated analyses and, where available, for uncalibrated analyses, stream flows will be measured and model flows will be balanced to approximate observed flow data. A mass balance on some conservative substances, such as chlorides or conductivity, should also be performed when possible.

3.3.10. Dispersion

For uncalibrated models, literature values of dispersion can be used if the value chosen does not dominate model calculations. Otherwise, model dispersions should be measured or based upon a measurement of dispersion on a similar Louisiana receiving stream.

For calibrated models, dispersion should be measured or calibrated to a conservative substance.

3.4 Model Projections

Model projections form the basis of the TMDL and WLA determinations.

3.4.1 Critical Conditions, Treatment Options, and Sensitivity

This section outlines model inputs and critical conditions to be used in performing model projections. Treatment level alternatives to be analyzed are also specified as are those model inputs to be included in a model sensitivity analysis.

Critical conditions are also referred to in EPA guidance as design conditions, but are generally referred to in this document as critical flow to avoid confusion with treatment facility design flows. These conditions are the reasonable "worst case" conditions for the waterbody. The following sections provide the definitions that will typically be used for critical conditions. In general point sources with continuous discharges present the greatest impact on the waterbody during low-flow (drought), and high-temperature conditions. Under some conditions, such as flow-related discharges (hydrographically controlled limitations), or waterbodies heavily impacted by nonpoint source pollutants, more appropriate critical conditions may be selected, and must be technically justified in the TMDL report. Critical conditions for toxic pollutants are discussed in section 2.5.

3.4.1.1. Summer Season Critical Conditions

1. Background flow = 7Q10 or 0.1 cfs whichever is greater.

2. Stream Temperature = 30 ^{o}C for summer months (typically May - Oct) or, when appropriate data are available, the 90th percentile daily water temperature for the months of interest.

Note that in nearly every situation appropriate data are available and should be utilized for determination of critical stream temperatures.

3.4.1.2. Winter Season Critical Conditions

1. Background flow = 7Q10 for season or 1 cfs, whichever is higher.

2. Stream Temperature = 20 ^{o}C for winter months (typically Nov - Apr) or, when appropriate data are available, the 90th percentile daily water temperature for the months of interest.

3.4.1.3. Dissolved Oxygen

For model projections a headwater dissolved oxygen concentration of up to 90 percent of dissolved oxygen saturation at the 90 percentile seasonal temperature will be allowed. In the projections, the loading to the stream is reduced until the model projects that criteria will be met. Any recommended BMPs resulting from the TMDL will be implemented throughout the subsegment to achieve this reduced loading. Under these conditions, the headwater dissolved oxygen will improve along with the dissolved oxygen in downstream reaches. In almost all cases, therefore, if the model projects a dissolved oxygen that meets the criteria immediately downstream of the headwater, the headwater dissolved oxygen cannot be lower than the criteria. We will therefore set the fixed headwater boundary condition at a value at least as high as the criteria for model projections.

3.4.1.4. UCBOD to $CBOD_5$ Ratio

UCBOD to $CBOD_5$ ratio = 2.3 for all treatment levels (Note: A ratio of 1.5 was allowed in the UOD calculation for the dilution method because the method is confined to secondary treatment and 1.5 is a representative number for that level of treatment using the dilution method.)

3.4.1.5. Projections for critical stream geometry and hydrology.

Projection of stream width and depth at critical flow will usually be made with the Leopold equations. Geometry projections may also be based on Manning's formula, or an exponential formula for stream discharge (Bowie, et al., 1985). Parameter and coefficient values should preferably be estimated from discharge and dye studies on the modeled stream. If these data are not available, literature values, or parameters from similar streams may be used. In either case, stream studies should be conducted as close to critical flow as possible to minimize hydrological projection errors.

3.4.1.6. Model Projection Kinetic Rates

1. K_d, K_n from calibration or default values
2. K_2 should reflect critical flow stream hydraulics
3. SOD and CBOD settling rates should reflect decreases in settleable CBOD with increased treatment.
4. Model projection algal activity should reflect observed activity unless some technical basis exists justifying a change. A large improvement in treatment plant effluent may effect algal activity.

3.4.1.7. Treatment Alternative Projections

Model projections of sanitary wastewater treatment facilities will generally be made and reported for the appropriate target levels of treatment as per the following protocol.

30 : 15 mg/l	($CBOD_5$: NBOD/4.3 or Org-N + NH_3-N)	Secondary treatment
20 : 10 mg/l	($CBOD_5$: NBOD/4.3 or Org-N + NH_3-N)	Advanced secondary treatment
10 : 10 mg/l	$CBOD_5$: NBOD/4.3 or Org-N + NH_3-N)	Advanced treatment
10 : 5 mg/l	($CBOD_5$: NBOD/4.3 or Org-N + NH_3-N)	Advanced treatment
10 : 2 mg/l	($CBOD_5$: NBOD/4.3 or Org-N + NH_3-N)	Advanced treatment
5 : 2 mg/l	($CBOD_5$: NBOD/4.3 or Org-N + NH_3-N)	Advanced treatment
5 – 6 mg/l	Dissolved oxygen	Post Aeration
No discharge		

If organic nitrogen and ammonia are modeled, the nitrogenous load will be proportioned between these parameters in accordance with data for the facility in question. If such data is not available, it will be assumed that the nitrogenous load is 1/3 ammonia for pond and lagoon systems and 2/3 ammonia for mechanical plants. The required treatment levels will be reported in the TMDL report as though ammonia comprised all of the nitrogenous oxygen demanding load.

Effluent DO of 2 mg/L will typically be assumed for secondary treatment, and 5 and/or 6 mg/L will be considered for more advanced treatment. In some cases, it may be necessary to evaluate all of the above levels to determine the minimum level that will support water quality criteria. Occasionally, plant specific levels of each constituent may be analyzed based on operating history. Certain alternative treatment systems such as rock-reed filters, artificial marshes and constructed wetlands, among others, are known to consistently produce effluents that are not represented by the above standard levels. Actual production numbers from similar facilities should be used in these cases.

3.4.1.8. Projection Sensitivities

A sensitivity analysis should be performed on all calibrated wasteload allocation models. The analysis should be performed at the recommended treatment alternative and should, at a minimum, include testing of K_2, K_d, K_n, SOD, algal activity, dispersion, stream depth, width, headwater flow, and background temperature. Each test parameter should be raised and lowered so as to cause a significant change in projection results. Each parameter should be varied by the same percentage above and below the reference value. An exception is temperature, which should be varied by 2 degrees C below the reference value, and either to 2 degrees above the reference or to 32 degrees C, whichever is smaller. Model temperature correction factors, particularly for nitrification, are not considered to be adequate for model projections above 32 degrees C.

3.4.2 Facility Flow

The flow of a treatment facility will be based on the Louisiana Water Quality Management Plan, permit application or permit, or an estimate of flow based on population serviced. The estimation of sanitary wastewater flow based on population serviced will be determined according to the "Sewage Loading Guidelines" developed by the Louisiana Department of Health (formerly Department of Health and Human Resources, LDHHR, 1984). For single family residences a population of 4 persons per residence may be used. A flow of 100 gallons per person per day may then be used to estimate anticipated flow. Other sanitary sources such as schools, restaurants, trailer parks, apartment buildings, or multiple family dwellings are provided with applicable flow values in the Guidelines.

For industrial wastewater the Louisiana Water Quality Management Plan, information from the permit application, or the maximum 30-day average flow for the last two years may be used as the flow.

3.4.3 Criteria for Scenic Streams

Additional consideration must be provided if the waterbodies under study are classified as scenic streams, or are tributary to a scenic stream. In this case, in addition to the numerical criteria, State Water Quality Standards require that "no degradation" of water quality occur in the segment designated as scenic because of the projected discharge from discharges that were not in existence prior to the scenic stream designation of the waterbody. In this case, this more stringent water quality criterion, antidegradation or the numerical criterion, should be applied for water quality planning.

For the purpose of WLA dissolved oxygen projections, "no degradation" will require that the concentration of dissolved oxygen must not be reduced by more than a statistically significant difference at the 90% confidence interval. In practice, this interval is difficult to estimate, and resource, time, and data requirements for such determinations would be generally prohibitive. Therefore, an acceptable alternative criterion allows a reduction of no more than 0.5 mg/L relative to the conditions existing at the time of designation of the scenic stream. Based on experience in post-survey instrument comparison, this value is roughly equal to a confidence interval for instrument repeatability in DO measurement, and therefore represents a minimum confidence interval. In any case, the "no degradation" requirement will be applied or modeled under critical stream conditions.

Where a discharge enters a tributary to a scenic stream, and the tributary has not been classified as scenic, the tributary is treated as any other stream. Additionally, however, the "no degradation" criterion must be satisfied within the scenic stream.

3.4.4 Hydrograph-Controlled TMDLs

In some situations the development of a hydrograph-controlled TMDL may be appropriate. In these cases the TMDL is determined as a function of stream discharge. The hydrograph-controlled TMDL may be appropriate where stream discharge is highly variable, a zero discharge or extremely stringent limitation would result from a critical flow based TMDL, effluent storage is feasible and economical, and resources are available for the complex modeling development required to support such a study. As in other cases, an appropriate MOS is required for hydrograph-controlled TMDLs.

3.5 Other Analytical Approaches

There are several types of water bodies for which dissolved oxygen water quality models are not generally reliable predictive tools. Swamps, wetlands, and some lakes fall into this category. For these waterbodies alternative methods for determining TMDLs should be used. Initially, however, a reconnaissance survey should be performed to support the determination of whether or not a model is appropriate, applicable, and available.

3.5.1 Lakes and Impoundments

Dissolved oxygen, nutrient enrichment and eutrophication of lakes present particular difficulties in analysis. Except in rare circumstances, large computerized, ecological models of lakes are not recommended for nutrient TMDLs. Large data requirements, lack of scientific consensus, as well as professional resource requirements makes these models impractical for most applications. From the standpoint of dissolved oxygen, if there are data which show that under current conditions water quality standards are being met and there are no nuisance problems associated with the discharger, then current effluent limitations should be adequate. For some impoundments of streams and bayous (sometimes referred to as run of the river lakes or stretch lakes), standard stream models may provide an adequate and appropriate management model. In this case dispersion and photosynthesis should be taken into account.

For lake nutrient loading, nutrient budget models may be used to determine if nutrient reductions should be considered, and the degree of reduction required. If nutrient loading is determined to be a problem, reduction of point source loading should be considered. The relative magnitude of nonpoint sources and their abatement possibilities should also be considered. Relocation of discharges or diffusers may be recommended to eliminate some localized or nuisance problems in lakes.

3.5.2 Swamps and Wetlands

Swamps and wetlands present another situation in which presently available, complex, computer models may not be appropriate for water quality management decisions. In some situations uses may be enhanced through such discharges, while in other cases, uses may be degraded or completely lost because of wastewater discharges to these water bodies.

For current dischargers to swamps, wetlands, etc. the current impact can be evaluated in terms of its impact on uses, and the physical, chemical, and biological impact. A comparison should be made between upstream and downstream sites. For those waterbodies not sufficiently defined by a channel, sites near the discharge may be compared to control or reference sites that are not as heavily impacted. Where the discharger is having a detrimental impact in terms of water quality standards and/or reduced quality and diversity of species, reduced effluent limitations should be imposed, or an alternative treatment system and effluent discharge system may be considered. Swamps and wetlands may be able to receive and assimilate the wastewater with proper diffusion of the effluent.

If upstream or control site data for swamps and wetlands show contravention of standards then the standards should also be reviewed. To prevent delays, the TMDL should concurrently be developed, and if necessary, the phased TMDL procedures applied. Comparisons to existing discharges can be utilized to estimate the impact of a proposed discharge.

3.5.3 Bacterial Related TMDLs

LDEQ has little experience with modeling of bacterial contamination and development of model-based bacterial management strategies. At present it is assumed that bacterial limitations or disinfection are necessary to protect human health uses for all significant sanitary dischargers. Future experience, modeling developments, and EPA guidance may demonstrate the needs for additional routine controls and TMDL procedures.

3.6 Outline For TMDL Reports

The following outline will result in a report that is self-supporting and capable of being a useful reference for persons not directly involved in its development. The appendix containing model input and output will allow analysts to duplicate the work in later years. Depending on the level of effort, some portions of the outline may not be applicable (e.g., verification). In addition, some of the topics on the outline may be addressed in a table or by a few statements. If an associated survey report is developed prior to or in conjunction with the TMDL report, duplicated information may be summarized with appropriate citations made to the survey report. A standardized procedure for determining the title of reports will be used for all TMDL reports as follows:

Title Format:

?WATERBODY? WATERSHED TMDL FOR BIOCHEMICAL OXYGEN-DEMANDING SUBSTANCES

Subsegment ??????

SURVEYED ?DATE?

Report Outline:

EXECUTIVE SUMMARY
Table of Contents

1. Introduction
2. Study Area Description
    - 2.1 General Information
    - 2.2 Water Quality Standards
    - 2.3 Wastewater Discharges
    - 2.4 Water Quality Conditions/Assessment
    - 2.5 Prior Studies
3. Documentation of Calibration Model
    - 3.1 Program Description
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    - 3.3 Model Discussion and Results
4. Water Quality Projections
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    - 4.2 Input Data Documentation
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    - 4.4 Calculated TMDL, WLAs and LAs
5. Sensitivity Analysis
6. Conclusions

7. References
8. Appendices
   APPENDIX A - Detailed TMDL Analyses
   APPENDIX B - Calibration Model Input and Output Data Sets
   APPENDIX C - Calibration Model Development
   APPENDIX D - Projection Model Input and Output Data Sets
   APPENDIX E - Projection Model Development
   APPENDIX F - Survey Data Measurements and Analysis Results
   APPENDIX G - Historical and Ambient Data
   APPENDIX H - Maps and Diagrams
   APPENDIX I - Sensitivity Analysis

3.7 Approval of TMDLs

In accordance with the requirements of the CWA, EPA-VI will review and approve or disapprove TMDLs submitted by the State. In consultation with the State, and within the resource constraints of the State, and within State priorities, disapproved submittals will be revised, if appropriate, and resubmitted for reconsideration by EPA. All finally approved TMDLs will be incorporated into the Louisiana Water Quality Management Plan through the procedures listed in the CPP.

4 PLANNING

LDEQ procedures for surface water quality monitoring, assessment and analysis are described in Quality Assurance Project Plans (QAPPs) prepared by the LDEQ. These documents provide descriptions of project plan development, reconnaissance and intensive survey planning, survey reporting, and laboratory QA/QC procedures. TMDLs and related work performed by the LDEQ will be governed by these procedures. TMDLs and related work performed by others will be governed by project specific QAPPs submitted to, reviewed and approved by LDEQ and EPA.

5 GLOSSARY

30Q2	30 day average low flow with recurrence of 2 years
7Q10	7 day average low flow with recurrence of 10 years
AT	Advanced Treatment
cfs	Flow in Cubic Feet per Second
BAT	Best Available Technology
BMP	Best Management Practice
BOD_5	5 day Biochemical Oxygen Demand

$CBOD_5$	Carbonaceous BOD_5
CPP	Continuing Planning Process, documentation required by 303(e) of the CWA
CWA	Clean Water Act
DO	Dissolved Oxygen Concentration
EL	Effluent Limited
EPA-VI	Region VI of the US EPA
ICS	Individual Control Strategy, established under section 304(l) of the CWA
K_2	Reaeration Rate
K_d	Carbonaceous BOD decay rate
K_n	Nitrogenous Decay Rate
K_s	CBOD Settling rate
LA	Load Allocation
LDEQ	Louisiana Department of Environmental Quality
MGD	Flow in Million Gallons per Day
mg/L	Concentration in Milligrams per Liter
MOS	Margin of Safety
MOU	Memorandum of Understanding
MZ	Mixing Zone
NBOD	Nitrogenous BOD
NH_3	Ammonia
NH_3-N	Ammonia nitrogen concentration
NPDES	National Pollutant Discharge Elimination System, the system of Federal discharge permitting

POTWPublicly Owned Treatment Works

QA/QC	Quality Assurance/Quality Control
SA	Surveillance and Analysis Section
SOD	Sediment Oxygen Demand
STP	Sewage Treatment Plant
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TSD	USEPA Technical Support Document for Water Quality Based Toxics Control
TSS	Total Suspended Solids
UAA	Use Attainability Analysis
UBOD	Ultimate BOD
UCBOD	Ultimate Carbonaceous BOD
UOD	Ultimate Oxygen Demand
WLA	Wasteload Allocation
WQL	Water Quality Limited
WWTP	Wastewater Treatment Plant
ZID	Zone of Initial Dilution

6 REFERENCES AND BIBLIOGRAPHY

Listed here are several documents and guidance manuals that are of special relevance to the TMDL process. The latest version should normally be used. This list is not all inclusive and in no way limits the usage of other suitable references. A review of EPA guidance documents related to the TMDL process is provided in Appendix A of the EPA's "Guidance for Water Quality Based Decisions: The TMDL Process," (USEPA, 1991a).

Bowie, G.L., et al. Rates, Constants, and Kinetics Formulations in Surface Water Quality Modeling (Second Edition). EPA/600/3-85/040. 1985.

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